IEC 62938

Edition 1.0 2020-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Photovoltaic (PV) modules – Non-uniform snow load testing

Modules photovoltaïques (PV) – Essais de charges de neige non uniformes

IEC 62938:2020-05(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 27.160 ISBN 978-2-8322-8074-4

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PHOTOVOLTAIC (PV) MODULES –
NON-UNIFORM SNOW LOAD TESTING

FOREWORD

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
82/1670/FDIS	82/1705/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

PHOTOVOLTAIC (PV) MODULES – NON-UNIFORM SNOW LOAD TESTING

1 Scope

This document provides a method for determining how well a framed PV module performs mechanically under the influence of inclined non-uniform snow loads. This document is applicable for framed modules with frames protruding beyond the front glass surface on the lower edge after intended installation and as such creates an additional barrier to snow sliding down from modules. For modules with other frame constructions, such as backrails formed in frames, on the side edges, on the top edge and on the lower edge not creating an additional snow slide barrier, this document is not applicable.

The test method determines the mechanical non-uniform-load limit of a framed PV module.

The loads specified in this document apply exclusively to natural snow load distributions. Any expected artificial accumulations (e.g. from snow removal or redistribution) are considered separately.

Methods to eliminate or counteract the occurence of inhomogeneous snow accumulation, such as a steep installation angle (more than 60°), are not included in this document. This document assumes a relationship between ground snow-cover and module snow-cover which may not be applicable in locations where the snow does not completely melt between snow falls. This document does not consider the effect of snow cover on power generation.

While the test method includes a wait time between load steps, the document does not provide a complete assessment of the fatigue behaviour of the materials of the module, such as front glass.

Because typical field failures of PV modules caused by snow load show glass breakage and frame bending, the test method aims at reproducing the load under which such failures occur.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 60904-13 :2018, *Photovoltaic devices – Part 13: Electroluminescence of photovoltaic modules*

IEC 61215-1:2016, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements*

IEC 61215-2:2016, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC TS 62915, *Photovoltaic (PV) modules – Type approval, design and safety qualification – Retesting*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
characteristic snow load
S_K
characteristic value of snow on the ground

Note 1 to entry: S_k is expressed in kN/m^2.

Note 2 to entry: The lowest value for S_k used in this document is 2,4 kN/m^2.

3.2
characteristic value of snow load
angle dependent snow load
S_A
product of the characteristic snow load on the ground and the snow load shape coefficient

Note 1 to entry: The lowest value for S_A used in this document is 1,47 kN/m^2.

3.3
snow load shape coefficient
μ_i
ratio of the snow load on the roof or PV module to the undrifted snow load on the ground

3.4
specific snow weight
γ
weight per unit volume of snow

Note 1 to entry: The specific snow weight γ is considered to be 3 kN/m^3.

3.5
snow load of the overhang
S_E
load vertical to the eaves applied in addition to the uniform load on a roof

3.6
fractile value
lower or upper bounds of a distribution function (Student's distribution, normal distribution, log normal distribution, etc.) which represents, in construction, strenghts or impacts

4 Sampling

At least seven PV modules are used for testing. Five or more modules are used to determine the maximum load bearing; one is used for determination of electrical degradation at a load below the determined maximum load bearing and one is used as a control module.

5 Prerequisites

The PV module type shall have passed the static mechanical load test (MQT 16) according to IEC 61215-2 with a minimum positive test load of 5 400 Pa.

6 Testing

6.1 General

These test specifications describe a test method for determining the direct load-bearing capability of framed PV modules under the effects of inhomogeneous snow loads.

6.2 Projections of the test results

Failure of the (adhesive) bond between module frame and glass/laminate can lead to

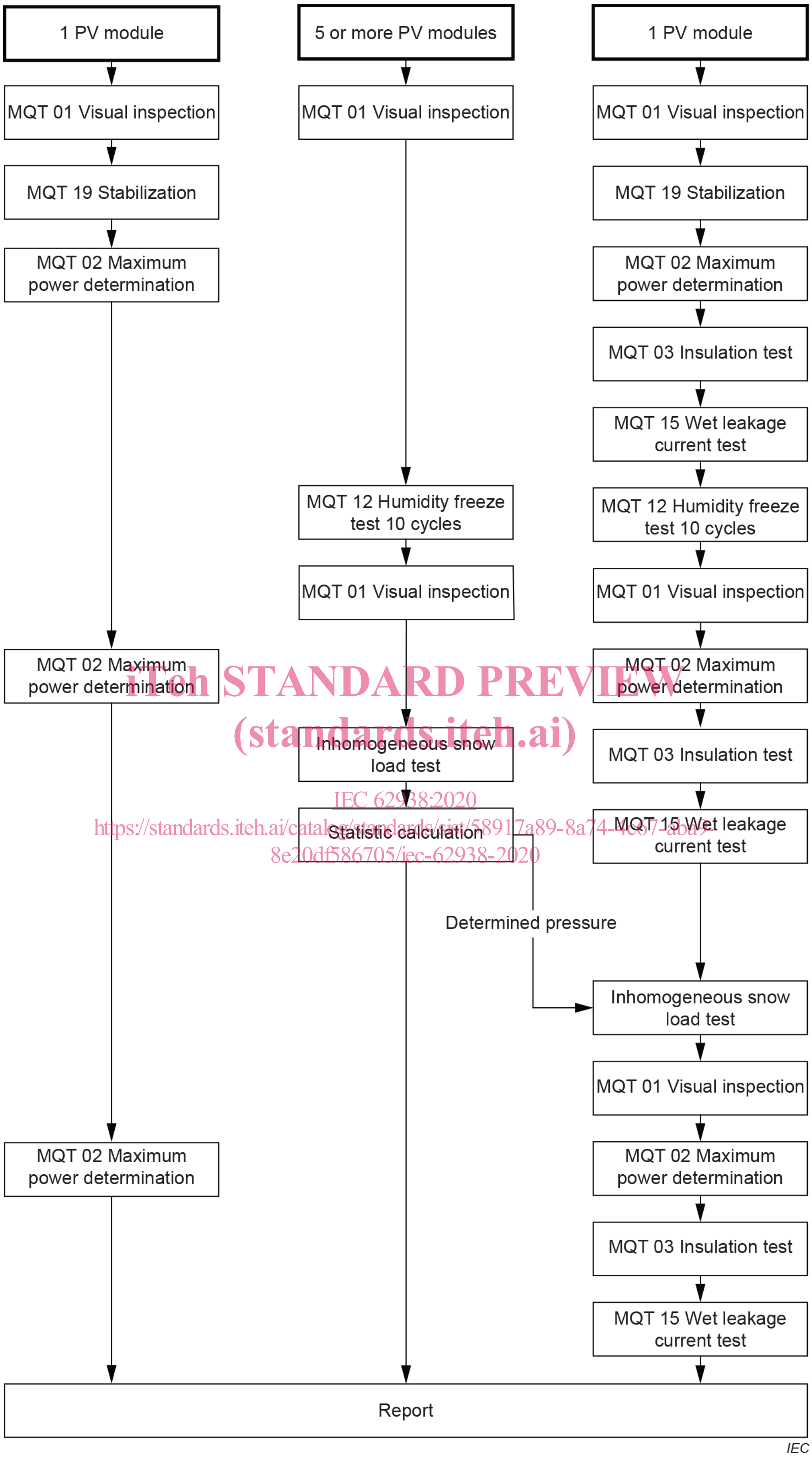
- deformation of the module rail or frame,
- glass breakage,
- displacement of rail or frame parts,
- fracture of rail or frame parts,
- loss of adhesion strength in adhesive bonds , and
- breakage or displacement of mounting parts.

In addition, this can impact electrical performance due to:

- interruption of the module's electrical insulation,
- cell breakage and junction box failure, and
- power degradation.

6.3 Test plan

Figure 1 shows the test flow where the numbers in the boxes represent the test references in IEC 61215-2. Five modules undergo the mechanical testing until failure as defined in Clause 8 occurs. A sixth module shall be used to determine the highest load bearing at which no power degradation > 5,0 % occurs.



NOTE The numbers in Figure 1 relate to the test references in IEC 61215-2:2016.

Figure 1 – Test plan for inhomogeneous snow load test

7 Test procedures

7.1 Visual inspection

This test is performed according to IEC 61215-2 MQT 01.

7.2 Maximum power determination

This test is performed according to IEC 61215-2 MQT 02 after initial stabilization according to IEC 61215-2 MQT 19. For intermediate and final control measurements, further stabilization steps might be required dependent on the module technology. The maximum power determination is a relative measurement only; the measurements do not need to be performed at standard test conditions (STC).

7.3 Insulation test

This test is performed according to IEC 61215-2 MQT 03.

7.4 Wet leakage current test

This test is performed according to IEC 61215-2 MQT 15.

7.5 Humidity-freeze test

This test is performed according to IEC 61215-2 MQT 12.

7.6 Electroluminescence imaging

Accompanying the visual inspection, electroluminescence according to IEC 60904-13 imaging could be performed optionally on the electrical verification module to visualize cell cracking.

7.7 Non-uniform snow load test

7.7.1 Purpose

This test specification describes a method for determining the direct load-bearing capability of inclined, framed PV modules under the effects of inhomogeneous snow loads.

7.7.2 Load specification

The inhomogeneous load distribution of the weights is determined by the diagram showed in Figure 2.

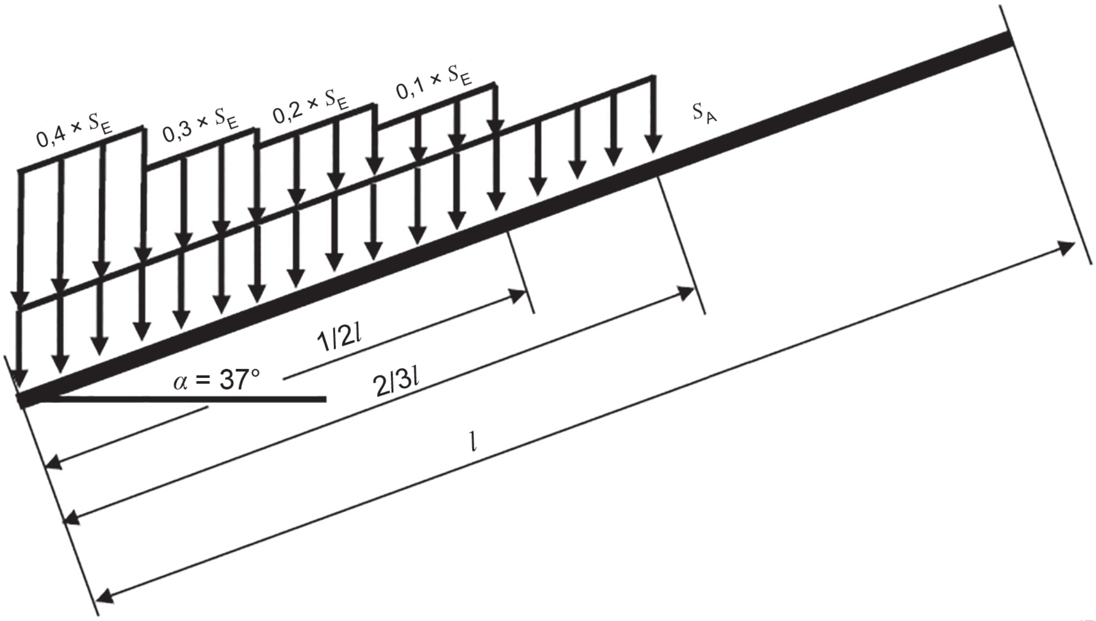


Figure 2 – Distribution of load on the test specimen at inclination

The load to be applied to the PV module and its distribution by means of separate weight elements is determined as a function of the characteristic snow load S_k, the module angle of inclination α = 37° ± 1°, the shape coefficient μ_i as a substitute value for pitch roofs, and the linear load generated from S_E as a function of an assumed specific snow weight of γ = 3 kN/m^2.

Here, it is assumed that the snow can slide off unhindered. For mono pitch roofs or PV modules, where the snow is not prevented from sliding off the roof, the values showed in Table 1 can be used (see also Annex A).

Table 1 – Applicable load in relation to angle of pitch of roof

Angle of pitch of roof α	0°< α ≤ 30°	30°< α < 60°	α ≥ 60°
μ_i	0,8	0,8 · (60° – α) / 30°	0,0

At a test angle of 37°, μ_i = 0,61 applies (this is considered as the most critical angle for snow slides).

The lower edge of the PV modules represent the eaves of a roof and hence this case needs to be considered in this document. The minimum of S_E is 0,72 kN/m.

$$S_E = S_A^2 / \gamma$$

where

S_E is the snow load of the overhang depending on eaves, in kN/m;

S_A is the snow load on the roof, in kN/m^2 ($S_A = \mu_i \cdot S_K$);

γ is the specific snow weight, in kN/m^2.

The weight elements for S_A are distributed over the bottom area of the inclined module over a length of approximately, but not greater than, 2/3 of the vertical length of the module (l).

The weight elements for S_E are distributed over the bottom area of the inclined module over a length of approximately, but not greater than, 1/2 of the vertical length of the module (l).

Quasi- triangle PV for the hipped and/or broach roof, and roof shingle PV which has very short vertical length are out of scope, because it is assumed less impact of snow slide.

The subsequent load increases shall be applied as angle-dependent loads per area. Each load corresponds to the angle-dependent pressure given the shape coefficient (example: in the first step, 2,4 kN/m^2 corresponds to an angle-dependent pressure of 1,47 kN/m^2 at 37° (±1°) inclination angle, as defined in Formula (1).

$$S_A = S_K \cdot \mu_i \qquad (1)$$

The linear load S_E is then calculated and increased according Formula (2):

$$S_E = (S_A{}^2/\gamma) \qquad (2)$$

To calculate the force which can then distributed inhomogeneously according to Figure 2, the result needs to be multiplied with the factors out of Figure 2 and the bottom length of the module L_b.

Example: Additional force for the bottom segment $= 0{,}4 \cdot \left(\frac{S_A{}^2}{\gamma}\right) \cdot L_b$

The initial load with which all tests begin is derived from the minimum design qualification of PV modules according to the static mechanical load test (MQT 16) of IEC 61215-2.

The initial load corresponds to the combination of characteristic snow load S_K of 2 400 Pa and linear load S_E. In this example:

$$S_K = 2{,}4 \text{ kN/m}^2 \qquad (3)$$

$$S_A = \text{angle-dependent load at } 37° = 1{,}47 \text{ kN/m}^2 \qquad (4)$$

$$S_E = 0{,}72 \text{ kN/m} \qquad (5)$$

The weight elements used shall be able to slide on the surface of the module with as little friction as achievable. For example, a polytetrafluoroethylene, PTFE surface on the weight elements is suitable.

For each total load, it shall be ensured that the individual weight elements be placed according to the distribution shown in Figure 2. Further weight elements (e.g. weight disks) are placed on the bottom half of the module to form the linear load S_E per Figure 2, in order to ensure a simulated "bulging" snow accumulation. A deviation of the distribution of up to ±10 % can be tolerated.

7.7.3 Apparatus

The test bench has a substructure on which PV modules can be mounted at 37° ± 1° as specified by the manufacturer.